

Lab 7

Axial Skeleton

□ Skull “Overview”

— consists of 3 categories of parts:

- **Neurocranium** (also called “*braincase*”, “*brain-pan*”).
 - ▶ “**Calvarium**” (also called “*skull cap*”) is a group of skull bones that includes the following:
 - Frontal Bone(s)
 - Occipital Bone
 - Parietal Bones
 - ▶ “**Base of the Skull**” (also called “*cranial base*”) is a group of skull bones that includes the following:
 - Ethmoid Bone
 - Sphenoid Bone
 - Occipital Bone
 - Frontal Bone(s)
 - Temporal Bones
- **Facial Skeleton** (“membraneous viscerocranium”)
 - ▶ Inferior Nasal Conchae
 - ▶ Lacrimal Bones
 - ▶ Mandible
 - ▶ Maxilla
 - ▶ Nasal Bones
 - ▶ Palatine Bone
 - ▶ Vomer
 - ▶ Zygomatic Bones
- **Sutures** (not all of them are listed in this lab):
 - ▶ Coronal Suture
 - ▶ Lambdoid Suture
 - ▶ Frontal Suture (also called Metopic Suture)
 - ▶ Sagittal Suture
 - ▶ Squamosal Suture
- Note: some sources count the following bones as belonging to the skull and others discuss them separately:
 - ▶ Hyoid Bone
 - ▶ Auditory Ossicles
 - Malleus (also called the “*hammer*”)
 - Incus (also called the “*anvil*”)
 - Stapes (also called the “*stapes*”)

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- **Frontal**
 - Usually 1 bone, rarely 2 bones.
 - 85% to 99% of people have just 1 frontal bone as the frontal suture (metopic suture) has usually closed for 95% of the population by 14 months of age.

 - **Supraorbital Foramen (or Notch)** — **Supraorbital Nerve**
 - a branch of **CN V₁: Ophthalmic Division of the Trigeminal Nerve** passes through it (hole 2 of 2).— “foramen” is Latin for “hole, opening, aperture, and to pierce”.

 - **Frontal Sinuses** — each drains into the **middle nasal meatus** via the frontonasal duct. The frontal sinuses are absent at birth, and reach full size after puberty. 5% of people have an absent frontal sinus!

 - **Frontal Suture (Metopic Suture)** — easily seen in the fetal skull.
— “metopic” is Greek for “the space between the eyes”.

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- **Parietal**
 - “parietal” is Latin for “wall”.
 - Borders are the main sutures of the skull:
 - **Sagittal Suture**
 - **Coronal Suture**
 - **Lambdoid Suture**
 - **Squamosal Suture** (or Squamous Suture)

 - **Sagittal Sulcus**
 - on the internal surface between both parietal bones.
 - is the location for the superior sagittal sinus.
 - bordering it are several pits for the arachnoid granulations.
 - where CSF returns to the superior sagittal sinus.

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- **Occipital**
 - “occiput” is Latin for “back of the skull”.

 - **Foramen Magnum**
 - “foramen magnum” is Latin for “great hole”.
 - has the following main structures passing through it:
 - **spinal cord**
 - spinal root portion of **CN XI: Spinal Accessory Nerve**

 - **Occipital Condyles**
 - on the base of the occipital bone by the foramen magnum.
 - joint for the **Atlas (C1)**

 - **Hypoglossal Canal**
 - hidden at the base of each occipital condyle.
 - **CN XII: Hypoglossal Nerve** passes through them.

 - **Jugular Foramen**
 - found on the border between the occipital & temporal bones.

 - **External Occipital Protuberance**
 - less pronounced in females. A landmark for EEG placement.

□ **Temporal**

— multiple etymologies of the name:

- The skull is thin and vulnerable here which alludes to the Greek word “*temnion*” which means “*to wound in battle*”.
- From the Latin “*tempus*” meaning “*time*”... a reference to the location those early grey hairs appear with age.

— divided into 4 parts.

□ Squamosal Region:

□ **Zygomatic Process**

— The full name is “Zygomatic Process of the Temporal Bone”
— it is one of the 3 parts of the Zygomatic Arch (“cheek bones”).

□ **Mandibular Fossa**

— the mandibular fossa and mandibular condyle for the TMJ.

□ Tympanic Region:

□ **External Acoustic Meatus**

— canal about 1 inch long in adults which leads to the ear drum.

□ **Styloid Process**

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□ Mastoid Region:

□ **Mastoid Process**

□ **Stylomastoid Foramen**

— passage for **CN VII: Facial Nerve** (hole 2 of 2).

□ Petrous Region:

— “*petrous*” is Latin for “*like a stone*”.

— The petrous region is very dense and tends to contain well-preserved DNA, even in very, very ancient skeletons.

— contains the cochlea, semicircular canals, and the 3 ossicles:

- **Malleus**
- **Incus**
- **Stapes**

□ **Internal Acoustic Meatus**

— looks like “*a small cave at the top of a mountain*”.

— passage for **CN VII: Facial Nerve** (hole 1 of 2).

— passage for **CN VIII: Vestibulocochlear Nerve**.

□ **Carotid Canal**

— passage for the **Internal Carotid Artery**.

□ **Foramen Lacerum**

— *Tip: the carotid canal is usually poorly molded in plastic skulls.*

— *it is technically not a “true foramen”, but rather a “jagged triangular opening” between the sphenoid, occipital and temporal bones that fills with cartilage soon after birth.*

□ **Jugular Foramen**

— looks like “*a large cave at the bottom of a mountain*”.

— found on the border between the occipital & temporal bones.

— passage for **CN IX: Glossopharyngeal Nerve**

— passage for **CN X: Vagus Nerve**

— passage for **CN XI: Spinal Accessory Nerve** (hole 2 of 2).

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- **Sphenoid**
 - “*sphenoid*” is Greek for “*wedge-like*” which the sphenoid bone resembles if viewed laterally.
 - a similar word “*os sphenoidale*”, means “*bone resembling a wasp*” which the sphenoid bone resembles if viewed anteriorly.

 - **Sella Turcica**
 - “*sella turcica*” is Latin for “*Turkish seat*”.
 - contains the **Pituitary Gland** (hypophysis). This space the pituitary gland is in is specifically called the “*hypophyseal fossa*”.

 - **Sphenoid Sinus**
 - found within the body of the sphenoid bone.
 - air filled, mucous-membrane lined cavity.
 - drains into the superior nasal meatus.

 - **Optic Canal**
 - passage for **CN II: Optic Nerve**
 - the angle between the optic canal and the midline of the skull is $34^\circ \pm 6^\circ$.

 - **Superior Orbital Fissure**
 - a cleft between the greater wing & lesser wing of the sphenoid that has the following structures passing through it:
 - **CN III: Oculomotor Nerve**
 - **CN IV: Trochlear Nerve**
 - **CN V₁: Trigeminal Nerve, Ophthalmic Division** (hole 1 of 2).
 - **CN VI: Abducens Nerve**

 - **Inferior Orbital Fissure**
 - is a space on the border between the sphenoid & maxilla.
 - **CN V₂: Trigeminal Nerve, Maxillary Division** (hole 2 of 3).

 - **Foramen Rotundum**
 - passage for **CN V₂: Trigeminal Nerve, Maxillary Division** (hole 1 of 3).

 - **Foramen Ovale**
 - passage for **CN V₃: Trigeminal Nerve, Mandibular Division** (hole 1 of 3).

 - **Foramen Spinosum**
 - “*foramen spinosum*” is Latin for “*hole full of thorns*”.
 - passage for the **middle meningeal artery**.
 - very poorly (incompletely) molded in many plastic skulls.
However, it can also be absent too in a real skull as well!

 - **Foramen Lacerum**
 - “*foramen lacerum*” is Latin for “*lacerated piercing*”.
 - *it is technically not a “true foramen”, but rather a “jagged triangular opening” between the sphenoid, occipital and temporal bones that fills with cartilage soon after birth.*
 - *as the internal carotid artery exits the carotid canal it turns toward the cavernous sinus at the superior part of the foramen lacerum, but does NOT go through it.*
 - *this angled connection to the carotid canal in a plastic skull is usually poorly molded and filled in with plastic where a hole should be.*
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□ **Ethmoid**

- “*ethmoid*” is Greek for “*sieve*”.
- it is easily vulnerable to destruction by fractures & infection.
 - the medial wall of the orbit is known as the orbital lamina (or **lamina papyracea**) because it is “*paper thin*”.
 - infections here can easily spread to the eye.

□ **Ethmoid Sinuses**

- also called “Ethmoid Air Cells”.
 - air filled, mucous-membrane lined cavity.
 - most of them drain into the superior nasal meatus.
 - almost always destroyed on a real skull with time due to the fragility and thinness of the bone here.

□ **Superior Nasal Conchae**

- the **superior nasal meatus** is the space beneath this ridge of bone that receives sinus drainage from the:
 - Ethmoid Sinuses (most of it).
 - Sphenoid Sinus.
- it is usually NOT molded at all on a plastic skull, and quite small on a cadaver (it is easily damaged during dissection).

□ **Middle Nasal Conchae**

- the **middle nasal meatus** is the space beneath this ridge of bone that receives sinus drainage from the:
 - Frontal Sinuses.
 - Maxillary Sinuses

□ **Perpendicular Plate**

- also called the “*vertical plate*” of the ethmoid bone is part of bony septum of the nose.

□ **Crista Galli**

- “*crista galli*” is Latin for “*crest of the rooster*”
 - shape comes from the fold of dura mater called the falx cerebri being anchored here & pulling on the bone.

□ **Cribriform Plate**

- “*cribriform*” is Latin for “*sieve*”.
- it is a series of holes that sit in a shallow depression called the **olfactory fossa**. There are 20 or more olfactory foramina on each side:
 - passage for **CN I: Olfactory Nerve**.
 - Cerebrospinal Fluid (CSF) can leak out if fractured.
 - *Naegleria fowleri* is a deadly amoeba infection known to cause fatal meningitis by swimming through these holes to get access to the brain.
 - depth of the olfactory fossa falls into one of three **Keros Classifications**:
 - Type 1: depth of 1-3 mm (26% of population).
 - Type 2: depth of 4-7 mm (73% of population).
 - Type 3: depth of 8-16 mm (<1% of population).
 - Type 3 is easier to fracture & erode.

□ **Maxilla**

- “*maxilla*” is Latin for “*jaw*”. Plural is “Maxillae”.
- all the upper teeth are imbedded in the maxillae.
- maxilla forms the anterior 2/3 of the hard palate.
- it is a commonly fractured bone in blunt force trauma to the mid-face. There are 3 classic types of transfacial fractures of involving the maxilla called **Le Fort fractures of the Skull**.
 - **Le Fort I:** “*horizontal*” break below the nose causing a “*floating palate*”.
 - **Le Fort II:** “*pyramidal*” break going above the nose
 - **Le Fort III:** “*transverse*” break through the orbits then angling downward through the cheeks and jaw. This causes “*craniofacial dissociation*”.

□ **Maxillary Sinus**

- was called the “*Antrum of Highmore*”.
 - air filled, mucous-membrane lined cavity (which has its own name — “*Schneiderian membrane*”).
 - drains into the **middle nasal meatus**.
 - the opening to drain them is high on the medial wall so that if you are standing erect, the sinus can not drain.
 - each sinus can hold about 10 mL.
 - floor of the sinus is right next to the roots of premolars and molars. Its thickness varies from 0 mm to 12 mm.

□ **Infraorbital Foramen**

- opens onto the mid-face about 6 mm to 10 mm below the eye.
- *it is technically the opening on the face of **infraorbital canal***.
 - **CN V₂: Trigeminal Nerve, Maxillary Division** (hole 3 of 3).

□ **Mandible**

- “*mandible*” is Latin for “*one used for chewing*”.
- is the largest, lowest, and “strongest” bone in the human face
- 2nd most common bone broken in the face:
 - #1 reason is vehicle accident
 - #2 reason is assault (i.e. punch to the face).
- all the lower teeth are imbedded in the mandible.

□ **Mandibular Condyle**

- part of the Temporomandibular Joint (TMJ).

□ **Coronoid Process**

- “*coronoid*” is Greek for “*hooked-shaped*”.
- insertion location for the Temporalis muscle.
- most common location of mandible fracture.

□ **Mandibular Foramen**

- passage for **CN V₃: Trigeminal Nerve, Mandibular Division** (hole 2 of 3).

□ **Mental Foramen**

- passage for **CN V₃: Trigeminal Nerve, Mandibular Division** (hole 3 of 3).

□ **Body of the Mandible**

- second most common location of mandible fracture.

□ **Fetal Skull Fontanelles**

- “fontanelle” is Latin for “*little fountain or spring*”.
- colloquially called “*soft-spots*” by many parents.
- variant spelling is “fontanel”.
 - spaces between the bones of the fetal and infant skull where the ossification is not complete and the sutures are not fully formed.

□ **Anterior Fontanelle**

- is the largest fontanelle which is found between the frontal & the 2 parietal bones.
 - is about 4 cm from anterior to posterior.
 - is about 2.5 cm from left to right.
 - is diamond-shaped.
 - typically closes around 12 to 18 months from birth.
 - clinically useful to evaluate infants for dehydration, meningitis, increased intracranial pressure, etc...
 - best place to do an ultrasound of the infant brain.

□ **Posterior Fontanelle**

- it is a small, triangular fontanelle between the occipital & the 2 parietal bones.
 - typically closes around 2 to 3 months from birth.
 - area that presents during “crowning” in a vaginal birth.

□ **Sphenoid Fontanelle**

- fontanelle on the side of the skull between the frontal, parietal, temporal, and frontal bones.
 - typically closes around 6 months from birth.
 - this location becomes the “**Pterion**” in the adult skull, which is the weakest area of the skull and blunt-force trauma here can lacerate the middle meningeal artery deep to it causing an epidural hematoma.

□ **Mastoid Fontanelle**

- fontanelle on the side of the skull between the parietal, temporal, and occipital bones.
 - typically closes around 6 to 18 months from birth.
 - this location becomes the “**Asterion**” in the adult skull... a landmark for some brain surgeries.

□ **Zygomatic**

- “zygoma” is Greek for “yoke”. *The bone “joins” the maxilla and temporal bones to make the arch of the cheek.*

□ **Nasal**

- forms the “nasal bridge”, the bony upper 1/3 of the nose.
- most common bone broken in the face.

□ **Palatine** — 2 L-shaped bones forming the posterior 1/3 of the hard palate.

□ **Inferior Nasal Concha** — **Inferior nasal meatus** is beneath it.
• **nasolacrimal duct** (canal) drains tears into this space.

□ **Vomer** — “*vomer*” is Latin for “*plowshare*”, which is the bone’s shape.
— forms the lower bony septum of the nose.

□ **Lacrimal** — 2 small bones on the medial wall of the orbit where the nasolacrimal sac collects the tears and sends them down the nasolacrimal duct.

□ **Hyoid Bone** — “*hyoid*” is Greek for “*upsilon-shaped*”, which is “U”-shaped.
— very rarely fractured accidentally (0.002% of all fractures) due to being well-protected by its location behind the mandible:
• 50% of strangulations fracture the hyoid.
• 27% of hangings fracture the hyoid.

□ **Manubrium** — “*manubrium*” is Latin for “*handle*”.

□ **Suprasternal Notch** — also called the “jugular notch”.
— Can measure intrathoracic pressure here.

□ **Clavicular Notch** — location of the sternoclavicular joint.
• fibrocartilage disc located inside the joint.

□ **Sternal Angle** — also called the “**angle of Louis**” or “manubriosternal junction”.
• *named after Antoine Louis (a French surgeon who designed a prototype of the guillotine in the 1770s)!*
— 2nd rib attaches at this level.

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- **Body of the Sternum (or Gladiolus)**
 - “*sternum*” is Greek for “*chest*”.
 - “*gladiolus*” is Latin for “*sword*”.
 - place for placing hands for CPR compressions.

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- **Xiphoid Process**
 - “*xiphoid*” is Greek for “*sword*”.
 - does not usually ossify till about age 40 years.

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- **Ribs**
 - 12 pairs of flat-shaped bones numbered from 1 to 12.
 - **Head of the Rib**
 - forms joint with thoracic vertebra.
 - **Tubercle of the Rib**
 - forms joint with thoracic vertebra.
 - **Head of the Rib**
 - forms joint with vertebra
 - **Costal Groove**
 - vein, artery, and nerve runs thru it.

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- **Sacrum**
 - “*sacrum*” is Latin for “*sacred bone*” referring to its protection of the reproductive organs.
 - triangular bone formed by the fusion of 5 sacral vertebrae between the ages of 18 to 30 years.
 - **Auricular Surface of the Sacrum**
 - forms the sacroiliac joint with the Ilium. Is “ear-shaped”.
 - **Anterior Sacral Foramina**
 - 4 pairs of holes where anterior divisions of sacral nerves exit.
 - **Posterior Sacral Foramina**
 - 4 pairs of holes where posterior divisions of sacral nerves exit.
 - **Sacral Hiatus**
 - location for access by anesthesiologist to do a caudal nerve block in the sacral epidural space.

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- **Coccyx**
 - “*coccyx*” is Greek for “*cuckoo bird*” referring to similarity to the beak of this bird.
 - 3, 4 or 5 rudimentary vertebrae that are partially fused together (usually into 2 or 3 segments).
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□ **Cervical Vertebrae**

— 7 cervical vertebrae.

— Vertebral Parts:

- **Body**
- **Pedicle**
- **Transverse Process** (with **Transverse Foramen**)
- **Lamina**
- **Spinous Process** (may be bifid)
- **Vertebral Foramen** (passage for **spinal cord**)

□ **Atlas (C1)**

— No vertebral body. No spinous process.

— articulates superiorly with the occipital condyles and allows the head to nod “yes”.

— has a facet joint for the dens (joint to shake head “no”).

□ **Axis (C2)**

— **Odontoid Process (Dens)**

- is the body of the atlas that descends during fetal development.

— “hangman’s fracture” is due to forceful hyperextension of the head & neck. Despite its name, you are more like to get one from a fall (60%) or a motor-vehicle accident (21%) with an upward strike to the chin (i.e. chin hits steering wheel).

- in a judicial hanging (death penalty case), a “hangman’s fracture” only occurs about 8% of the time.

□ **Thoracic Vertebrae**

— 12 thoracic vertebrae.

— Vertebral Parts:

- **Body**
- **Pedicle**
- **Transverse Process**
- **Lamina**
- **Spinous Process** (slender & angled downward).
- **Vertebral Foramen** (passage for **spinal cord**)

□ **Lumbar Vertebrae**

— 5 lumbar vertebrae.

— Vertebral Parts:

- **Body**
- **Pedicle**
- **Transverse Process**
- **Lamina**
- **Spinous Process** (blunt & projects “strait back”).
- **Vertebral Foramen** (passage for **cauda equina**)

□ **Intervertebral Disc**

— between the vertebral bodies of each neighboring vertebra.

— **anulus fibrosus** on the outside

— **nucleus pulposus** on the inside.
